Fisheries and the Environment FATE

Fisheries Oceanography

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Outline

- FATE Overview
- Program Statistics
- TOR Questions
- Challenges
- Opportunities

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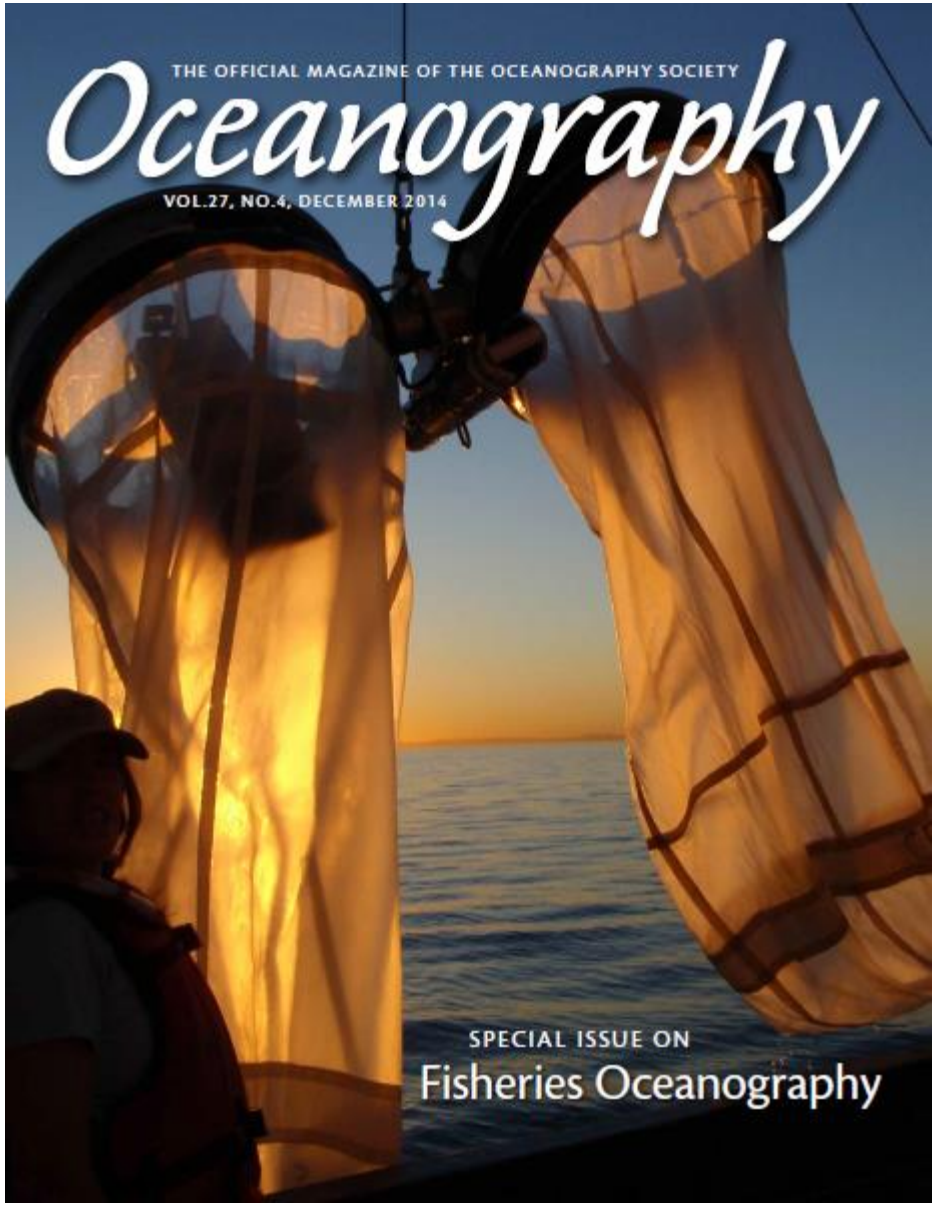
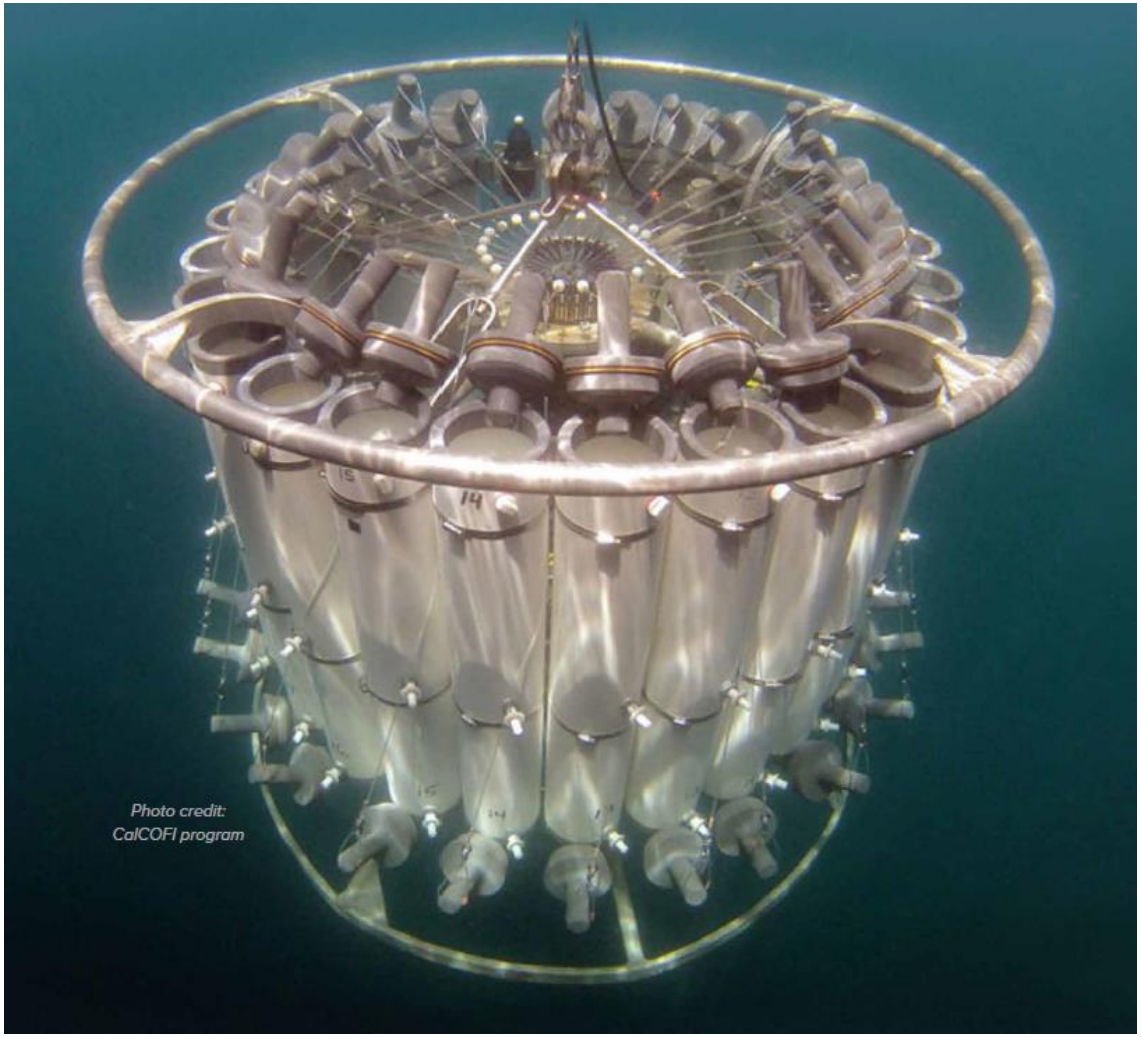
Knowledge of the linkage between environment and fisheries is critical

Sudden shifts in environment can have immediate and major impacts on fisheries productivity

Fisheries oceanography takes climate data, places it in context, and makes it usable at the population level

Fisheries oceanography is an essential element of ecosystem approach to management

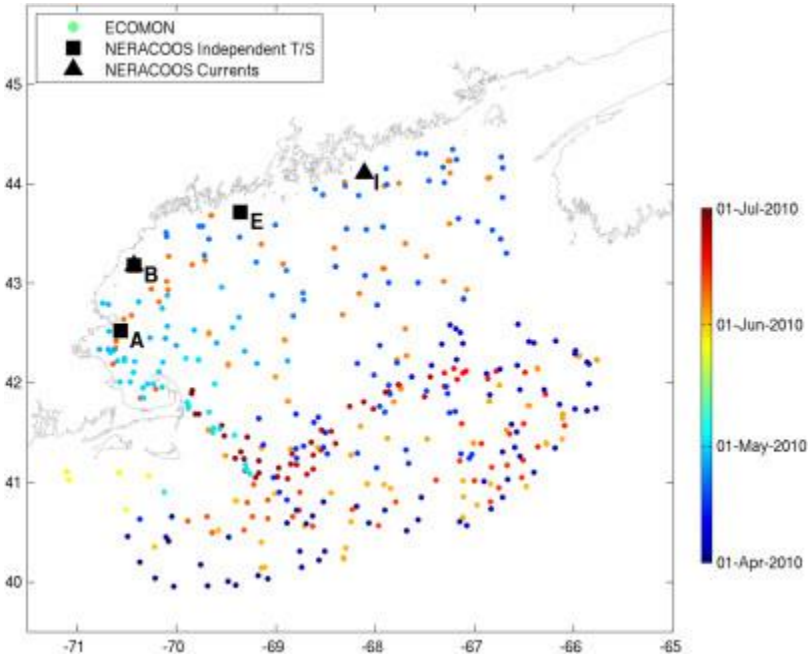


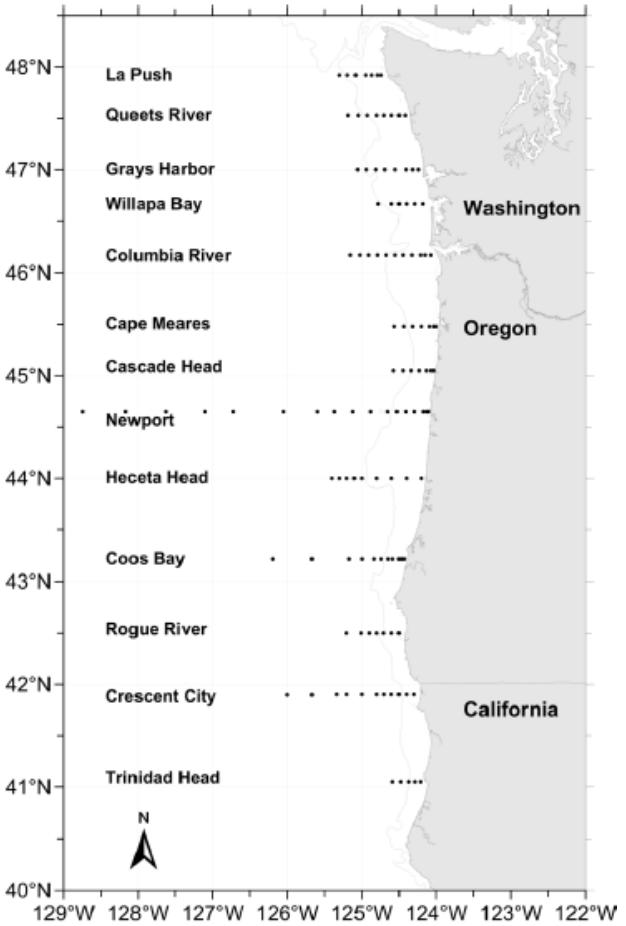


Produce ecological and oceanographic products for the purpose of improving fishery stock assessments, integrated ecosystem assessments, and ecosystem status reports

Connections…

- Oceanography Divisions at Science Centers
- Population Dynamics Divisions at Science Centers
- Numerous Projects within NOAA and in Community
- Fishery Survey Effort (Trawls and Ecosystem Cruises)
- Research Programs across USG (e.g., NASA, NSF)





Oceanographic transects and oceanographic sampling during all NMFS cruises are essential to sustain this NMFS capability

Fisheries Oceanography & NOAA Mission

- NOAA Mission
  - To understand and predict changes in climate, weather, oceans, and coasts, To share that knowledge and information with others, and to conserve and manage coastal and marine ecosystems and resources

- NMFS Mission
  - Stewardship of living marine resources through science-based conservation and management and the protection and restoration of healthy ecosystems

- Fisheries Management Goal – supports the above via:
    - stock assessments,
    - ecosystem status reports, and
    - integrated ecosystem assessments

****FATE projects are designed to support these****

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FATE – Program Statistics

- Issue one internal request for proposals per year
- ~$1.5M per year invested in new projects
- ~10 projects per year

- What is the demand relative to our capacity?
  - Approximately 500 stock assessments at NMFS
  - Each year, about 90 of those are updated
  - Assume 1/3 require environmental input (30 assessments)
    - FATE rate of delivery:
      - ~10 projects per year
  - Demand >> Capacity

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TOR #1: Goals and Objectives

- Initial Goal (2002)
  - "…broad scale, basin-wide forcing that is a common property of the dynamics of major stocks of west coast of North America and Alaska, and the central concept of FATE."
  - Develop "Leading ecological indicators"
  - Use permanent research staff and short-term projects (1-2 y funding)

TOR #1: Goals and Objectives

- Today's Goal
  - Develop and evaluate ecological and oceanographic indicators to be used to advance an ecosystem approach to management by improving stock assessments and integrated ecosystem assessments

TOR #1: Goals and Objectives

- Strategy to achieve today's goal
  - FATE supports research on the functional relationships between environmental forcing, competition for prey, or predation on the growth, distribution, or reproductive success of managed species
- Manage an annual internal call for proposals and use an NSF-style panel review to select projects for funding

TOR #1: Goals and Objectives

- An unstated goal…
  - "home" for fisheries oceanography within NMFS
  - Place to go to discuss state of the science
  - Place to go to propose new research efforts related to our mission

TOR #1: Role in NMFS ecosystem science

FATE was doing ecosystem indicators before is was cool to do ecosystem indicators.

TOR #1: Role in NMFS ecosystem science

What are the broad goals of the fisheries oceanography program at SWFSC?

In the wider context we are addressing how climate variability and climate change affect California's fisheries. Our focus is on small pelagic fish (for example sardines), but extends to squid and also to krill, which are important forage for fish, seabirds and marine mammals. We use statistical analyses of long-term datasets derived from the CalCOFI program to quantify how climate influences the habitat of sardine and squid. Our research also aims to develop environmental indices that can be used as inputs to improve stock assessments.

This statement represents the goals of FATE

TOR #1: Role in NMFS ecosystem science

- Stock Assessments
  - Another variable beyond spawning stock biomass
  - Inform SA models to past conditions outside the available fisheries dependent data
    - Newest models can provide future state
  - Inform to fish not yet available to the fishery or surveys (larval)

TOR #1: Role in NMFS ecosystem science

Examples of ecosystem data that may inform stock assessments include:

- Time series of physical or environmental data (e.g., ocean temperature, currents, etc.) help understand fluctuations in fish stocks and improve calibration of surveys
- Effects of large-scale climate processes (e.g., El Niño) and climate change.
- Species habitat utilization. Predator-prey and other studies that provide more accurate values for important stock assessment parameters such as natural mortality.

TOR #1: Role in NMFS ecosystem science

- Stock Assessments – three ways
  - Direct adjustment of the stock assessment model
    - SSH into sablefish
  - Augmentation of stock assessment discussions at Council
    - Ecosystem Considerations from AFSC
  - Engage in the stock assessment process*

TOR #1: Role in NMFS ecosystem science

- Engage in the stock assessment process*
  - Data Workshop
  - Assessment Workshop
  - Review Workshop
  - External Review
  - Present to SSC
- Fisheries oceanography engagement at *Data Workshop, Assessment Workshop, and Review Workshop* allows the best use of research results
- Move to collaborative inputs and development within this process

TOR #1: Role in NMFS ecosystem science

- IEAs
  - Indicator development
    - “synthesis of existing data sets that result in development and validation of ecological indicators which contribute to an integrated ecosystem assessment”

TOR #1: Program Structure

- 12- member steering committee
  - oceanographer, stock assessment biologist from each Science Center
- Program Manager at HQ
- FATE federal employees at each Science Center

- Every year an internal NMFS RFP is distributed to Science Centers.
- NSF-like proposal review panel recommends proposals for funding

TOR #1: Prioritization procedures

- Request for proposals point submitters to 6 FATE priorities
  - Developed Science Center priorities
  - Grouped into 6 priorities

TOR #1: Research Priorities

- Develop indices to predict interactions between fisheries and environment (climate, oceanography)
- Models
- Indicators for status reports, IEAs
- Examine climate effects on fisheries
- Forecast climate and oceanography in short (1-10 y) and long-term (20-50 y)
- Incorporate into stock assessment models

TOR #1: Research Priorities

- Alignment to Science Center priorities
  - Research priorities are reviewed annually by FATE steering committee
  - Science Center directorates approve proposals for submission to FATE

TOR #2: Program Integration

- Connections to other Programs
  - By design, FATE research results contribute to and are incorporated in:
    - Stock assessments by Population Dynamics Divisions
    - Integrated Ecosystem Assessments assembled by teams at Science Centers
    - Ecosystem Status Reports
  - Constant contact with other S&T RFP Programs

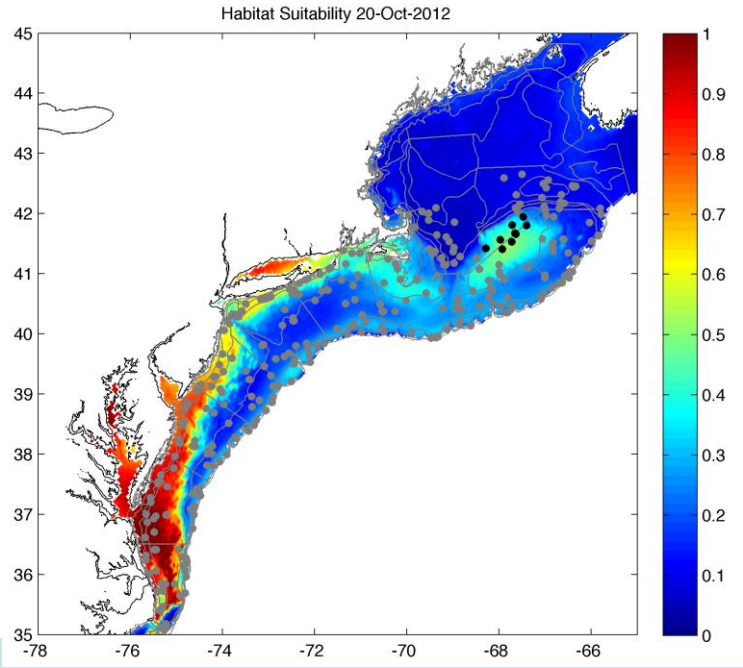
TOR #3: Providing information to others

What does a successful FATE project look like?

Butterfish in NEFSC:

Improve stock assessments and increase ABC

- **Issue:** long-finned squid fishery limited by the butterfish bycatch cap
- **Solution:** advance the prediction of butterfish distribution: refine oceanographic fields and build habitat model
- **Results:** Temperature predicted habitat. The habitat maps developed suggested the fishery survey was missing many butterfish. The population information was updated
- **Impact:** The butterfish allowable biological cap (ABC) increased from 1,500mt (2010) to 35,000mt (2014)

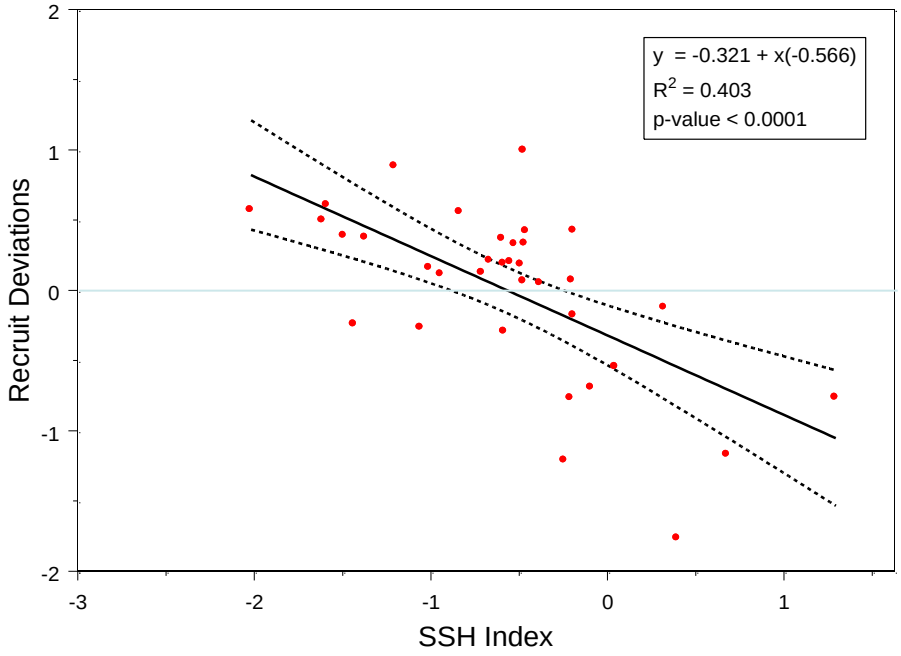


FATE & Habitat Programs: Manderson et al.

Sablefish off WA, OR

Reduce uncertainty and improve future projections

- **Issue:** Young sablefish survival is highly variable and estimation of year-class strength is difficult
- **Solution:** combine oceanographic time series (S, T, SSH) into sablefish stock assessment base model
- **Results:** Found a positive relationship between the North Pacific Polar Front and sablefish survival.
- **Impact:** The new sablefish assessment model reduced 17% unexplained recruitment variability and increased future projections of spawning biomass

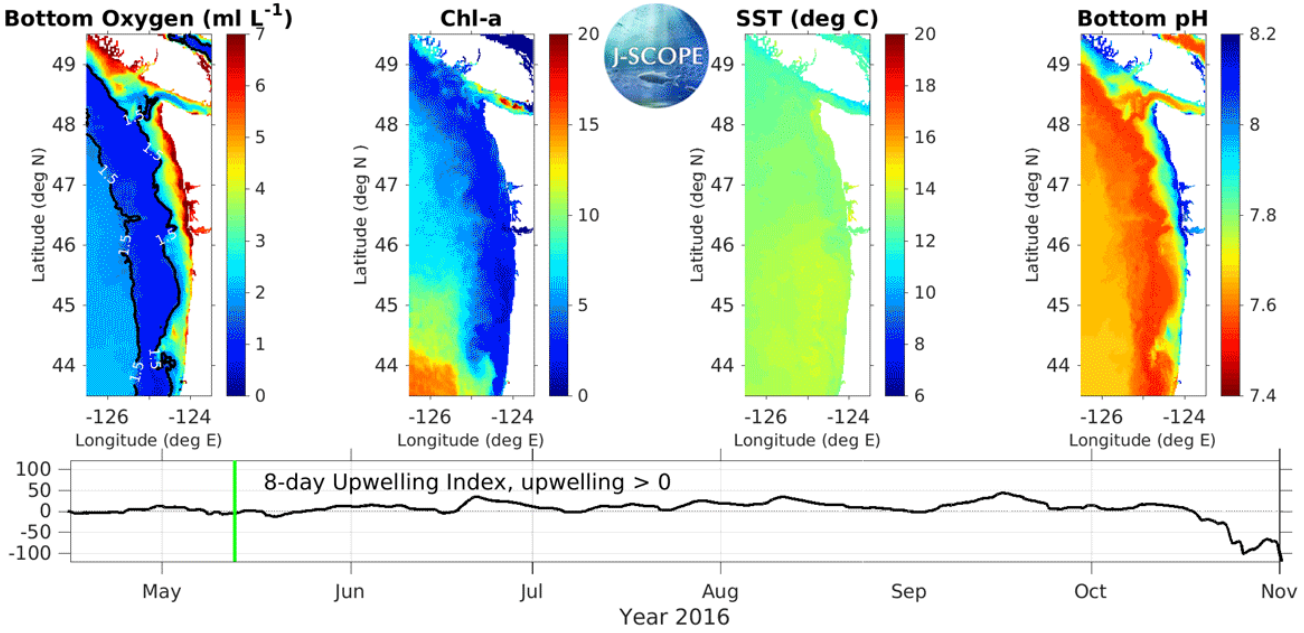


FATE & IEA Programs: Schirippa et al. – NWFSC

J-SCOPE in NWFSC

Seasonal prediction for managers to make weekly to quarterly decisions

- **Issue:** Climate change caused many sardines to seek more northern, colder waters and resulting in Pacific sardines decreasing
- **Solution:** J-SCOPE (JISAO's Seasonal Coastal Ocean Prediction of the Ecosystem) provides short term forecasts of ocean condition
- **Results:** An ability to forecast sardine distributions 4– 8 months in advance
- **Impact:** Serve as an early warning signal for the Pacific Fishery Management Council to make decisions on a monthly or quarterly basis.

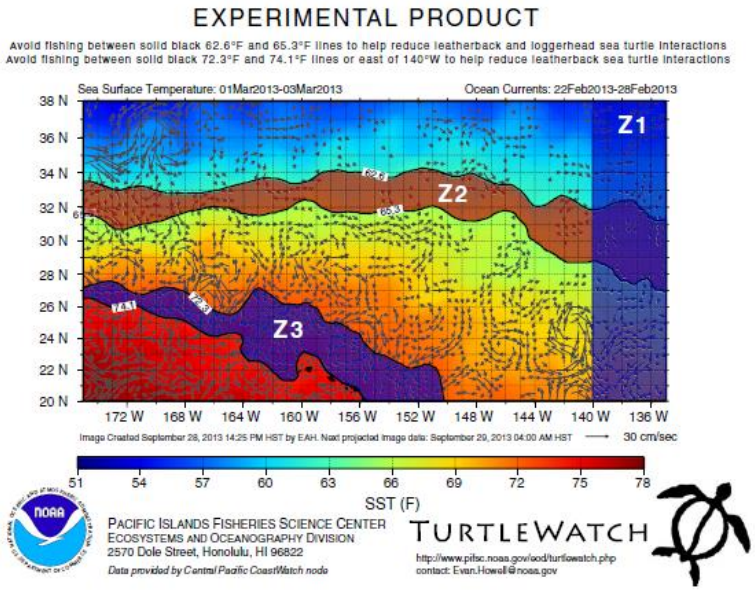


FATE & IEA: Kaplan et al. - NWFSC

TurtleWatch in PIFSC

Reduced bycatch and decrease longline fishery closure

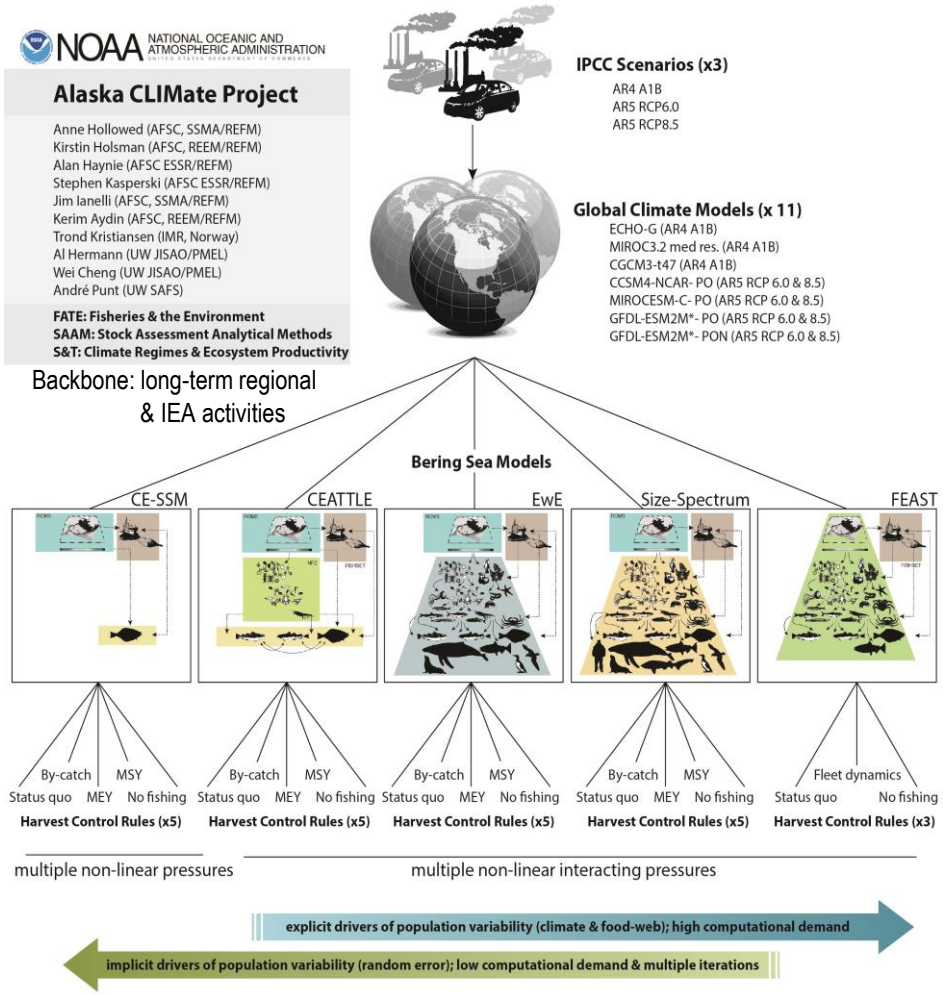
- **Issue:** longline fishery closed due to sea turtle encounters
- **Solution:** Build a thermal habitat model of sea turtles
- **Results:** Identify a thermal habitat range (63.5 - 65.5 °F) and build a real-time map to help fishermen avoid encountering loggerhead and leatherback turtles
- **Impact:** Fishery avoids more than 50% of turtle interactions; longline fisheries closures shorter



FATE: Howell and Polovina - PIFSC

Alaska Climate Project – ACLIM

Projecting future conditions and management strategies

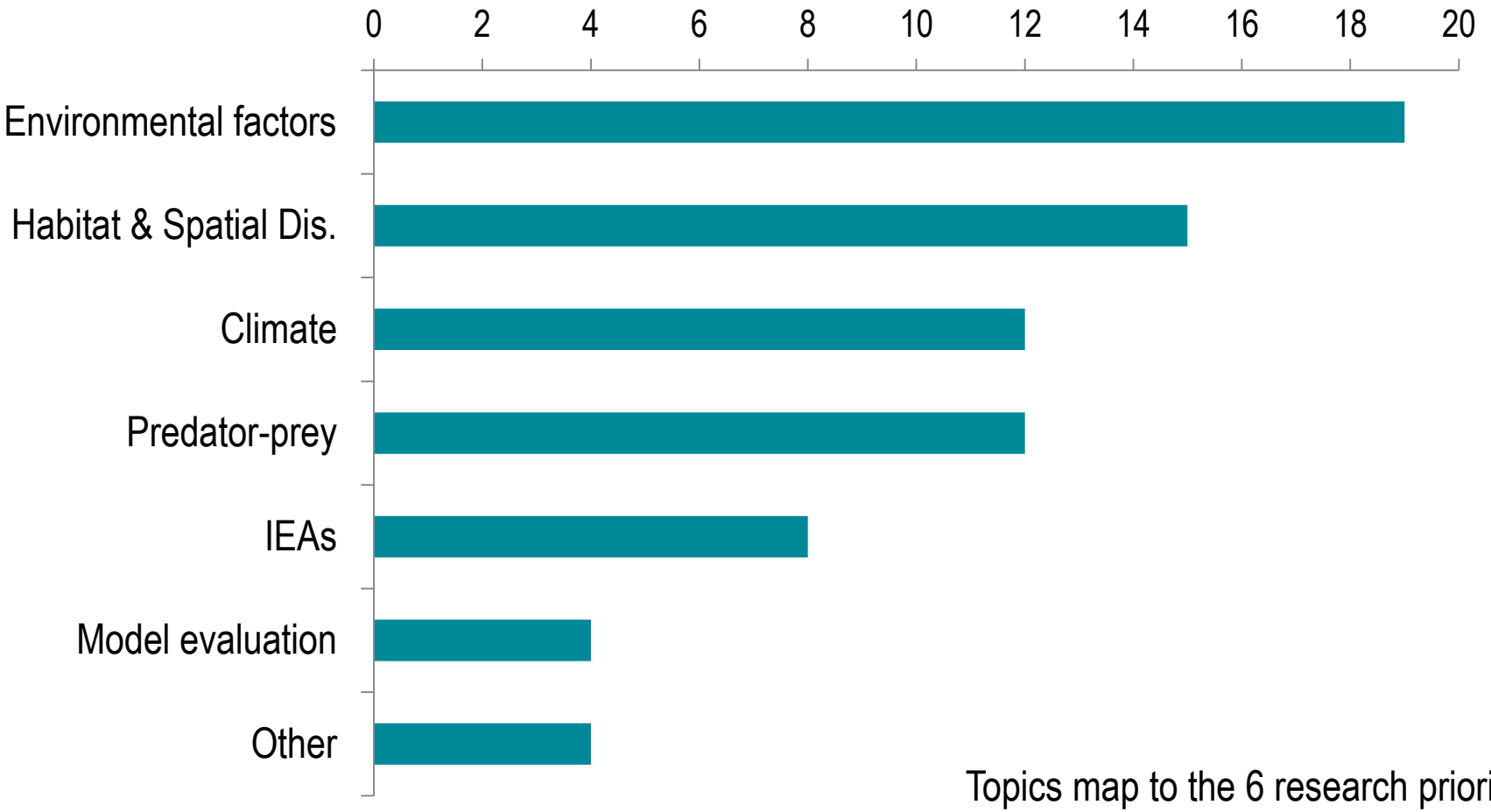


- Climate scenarios
- Ocean scenarios
- Ecosystem scenarios
- Fishing scenarios
- Management scenarios
- Informed Options

FATE, SAAM, Climate: Hollowed et al. - AFSC

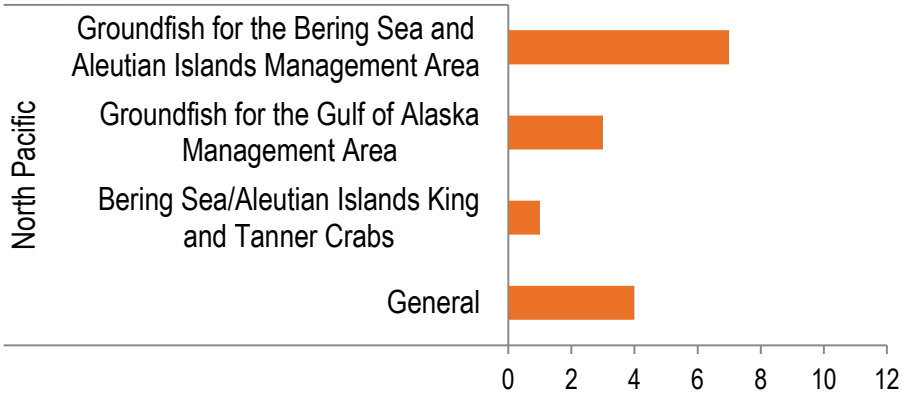
TOR #3: Providing information to others

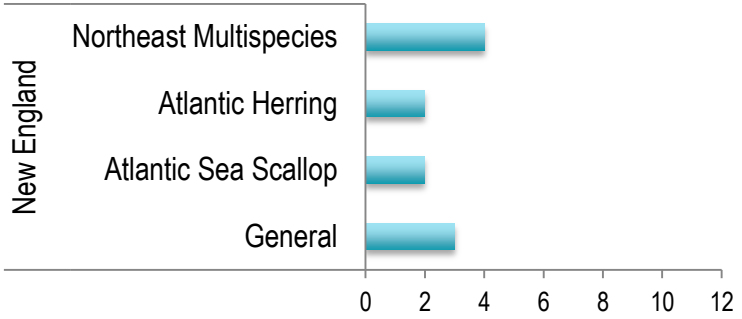
Project topics

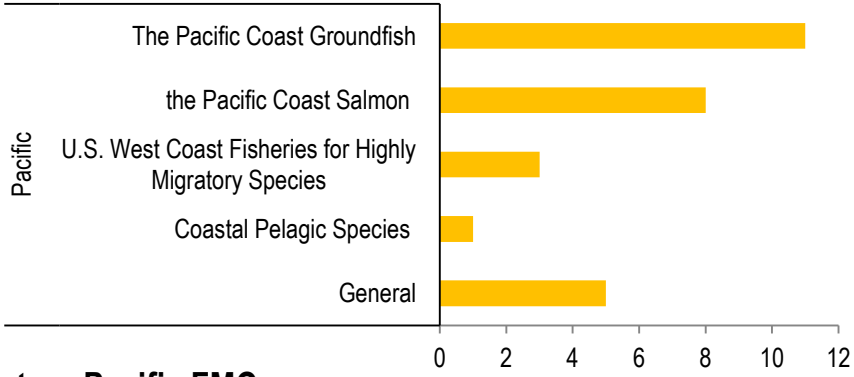


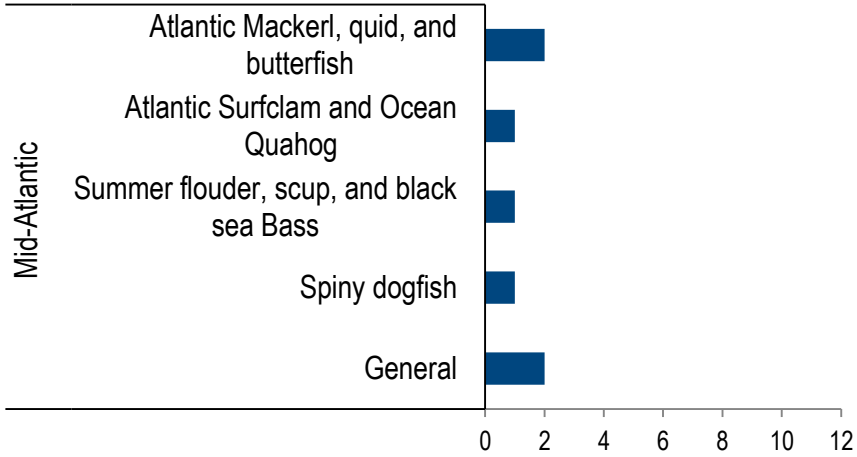
Topics map to the 6 research priorities

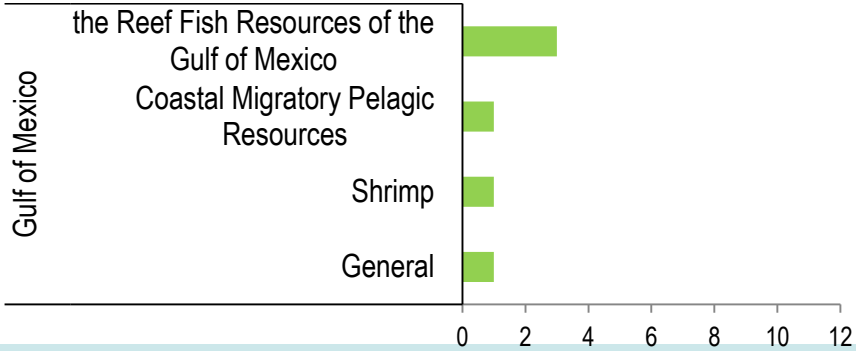
TOR #3: Providing information to others











- **Western Pacific FMC:**
  The Hawaiian Archipelago FEP (1), General (1)
- **Atlantic States Marine Fisheries Commission:**
  Shad and river herring (1), Atlantic menhaden (1)
- **Gulf States Marine Fisheries Commission :**
  Menhaden (1)
- **International Commission for the Conservation of Atlantic Tunas:**
  Atlantic tunas (1)

TOR #4: Suite of all Programs

- Under one Division at S&T allows easy conversation about:
  - Incoming proposals
  - What will be funded
  - Build collaborative projects
  - Balance a broad portfolio

TOR #5: Communication

- Stakeholders
- Public
- NOAA/NMFS Leadership

TOR #5: Communication

- Stakeholders
  - Modes of interaction
    - To stock assessment staff
      - Consultation
      - Co-PI
      - Route to engage FMC
    - To IEA teams
      - Contribution of indicators
      - Co-PI
      - Route to engage FMC and other management bodies

TOR #5: Communication

- Public
  - Not the major pathway for FATE research results
    - Augment, inform SA, IEA
  - FATE website
  - Media interactions, interviews
    - Warm blob

TOR #5: Communication

- NOAA/NMFS Leadership
  - Engage NMFS Fisheries Science Board as needed
  - Science Center Directors updated by SSC during the annual process
    - RFP development
    - Proposal submission
    - Panel results
    - Project execution
    - Delivery of results

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Strengths

- FATE influential for over 10 years
- FATE work is a critical element of new initiatives
- Leverages valuable record of oceanographic and ecosystem data

Challenge & Opportunity

- Challenge: Maintain limited capacity for oceanographic and ecosystem surveys
  - Need:
    - robust data to support indices and indicators
    - understanding of process, functional relationships
- Solution:
    - articulate the application of fisheries oceanography
    - engage more completely in the stock assessment *process*

Challenge & Opportunity

Challenge: Tracking the use of research results post-FATE

- From fishery oceanography to catch levels

Solution: Regular, Center-based assessments of FATE projects

- Annual activity

Challenge & Opportunity

Challenge: Lack of scientific program in academic sector that shares FATE priorities

- NSF programs like GLOBEC, CAMEO no longer exist

Solution: Increase communication with NSF

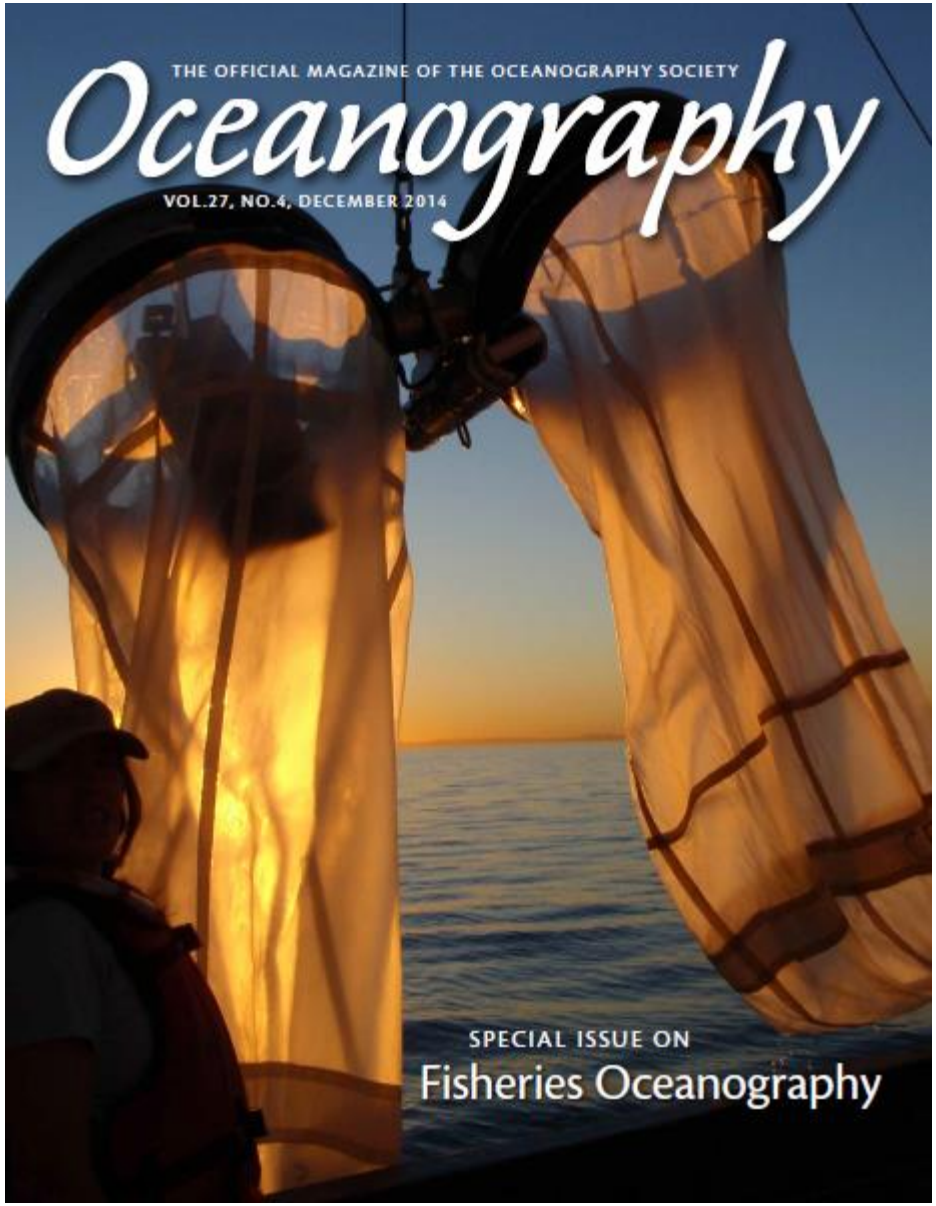
- Begin to explore development of a new NMFS/NSF research program

Knowledge of the linkage between environment and fisheries is critical

Sudden shifts in environment can have immediate and major impacts on fisheries productivity

Fisheries oceanography takes climate data, places it in context, and makes it usable at the population level

Fisheries oceanography is an essential element of ecosystem approach to management



Thank you

SUPPLEMENTAL INFORMATION

TOR #1: Research Priorities

1. Develop indices of environmental and oceanographic indicators, test hypotheses, or evaluate analytical tools to investigate specific mechanisms driving interactions between fisheries and climate and environmental drivers of managed species. Vital rates and parameters of interest include: 1) recruitment, 2) growth, 3) distribution, 4) spatial availability, including changes in observation processes (e.g., survey availability due to SST changes; harvest rate due to distribution or aggregation pattern changes), 5) trophic ecology, 6) maturity 7) natural mortality, 8) health, 9) habitat availability, and 10) larval dispersal. Such studies should directly improve stock assessments or protected species management via explanation and/or prediction of variability in the above population processes.

TOR #1: Research Priorities

2. Develop spatial and/or temporal models or analyses that investigate climate and environmental variability on: 1) population distributions, 2) growth, 3) recruitment, 4) maturity, 5) fecundity, 6) migration, 7) distribution, 8) natural mortality, 9) larval dispersal, and 10) predator-prey interactions based on the availability and distribution of forage species, climate and environmental covariates, and fishery interactions. Evaluate how the impacts of climate and environmental variability can be separated from anthropogenic factors when providing management advice for fisheries, marine mammal, and protected species management.

TOR #1: Research Priorities

3. Develop, improve, or augment indicators that are currently or could be used in ecosystem-based fisheries management (e.g. Ecosystem Status Reports to Fishery Management Councils or Integrated Ecosystem Assessments). Such indicators should investigate the impacts of climate and environmental drivers, and their associated uncertainty, on fish and fisheries management. Management strategy evaluations that evaluate alternative harvest control rules given predicted climate conditions, that investigate potential climate-change induced shifts in biological reference points, and that aim to define how these indicators can inform Council management actions are particularly encouraged. Investigations of climate or ecosystem reference points that identify thresholds to trigger management actions for managed fish stocks are also of interest.

TOR #1: Research Priorities

4. Examine the potential effects of climate variability, climate change, and fishing on managed species, protected resources, and ecosystems. Proposed research may use historical data and/or forecasting tools to predict future impacts.

TOR #1: Research Priorities

5. Evaluate the feasibility of forecasting oceanographic and climate processes and improving forecast skills for these processes and their ecosystem impacts over short (1-10 years) and/or long-term (20-50 years) time periods. Of particular interest is the application of IPCC climate scenarios coupled with management strategy evaluations to produce long-term impacts of climate change for managed species.

TOR #1: Research Priorities

6. Explore the feasibility and evaluate the utility of incorporating climate/environmental/oceanographic indices into stock assessment models and/or protected species assessments. Identify how environmental indicators can supplement or be considered alongside stock assessment output. The incorporation of environmental and climate forecasts into stock assessments is of particular interest.